High-Dose Radiation Health Effects Studies Notes

This presentation addresses the high-dose radiation health effects studies that support adaptive protection and refute the LNT dose-response model.

Slide 2 – high-dose radiation exposure data from studies of

- radium dial painters
- atomic bomb survivors
- Chernobyl first-responders
- Goiania, Brazil radiological accident victims and survivors

Slide 3 – radium dial painters

- beginning about 1915, many women employed in well-paying jobs to paint hands and faces of clocks and watches with radium paint
- little was known at time about radiation or its effects
- experienced chronic internal radiation exposures

Slide 4 – radium dial painters (cont.)

- Ra-226 accumulated in bones
- 64 bone sarcomas observed in 264 dial painters with >100 µCi of Ra-226 intake
- no sarcomas observed in 2119 painters with <100 µCi intake
- 30-year follow-up of 1155 painters with intakes <100 µCi showed lower cancer incidence and longer life span

Slide 5 – radium dial painters (cont.)

- study established threshold for ingested Ra-226 cancer risk of about 10 Gy

Slide 6 – atomic bomb survivors

- almost 200,000 Japanese killed when atom bombs dropped on Hiroshima and Nagasaki in 1945
- vast majority killed by thermal blast (fireball) and subsequent pressure blast (shockwave) that destroyed buildings in which people were located
- <10% of deaths were result of acute radiation syndrome (radiation “poisoning”)
- survivors subjected to high, acute radiation doses extensively studied by Radiation Effects Research Foundation (RERF)
- experienced acute external radiation exposure

Slide 7 – atomic bomb survivors (cont.)

- Life Span Study estimated acute plus chronic whole-body exposures

- reconstructed dose data for 11,300 survivors receiving high radiation exposures most important source of data for evaluating risks of low LET radiation at low and moderate doses
- main latent effect is cancer; increased risk for doses >200 mGy, decreased mortality rate and increased life expectancy for doses <200 mGy
- occurrence of inherited genetic changes in humans by ionizing radiation sufficiently rare to be undetectable in multi-generational studies of atomic bomb survivors

Slide 8 – Chernobyl first responders (1986)

- tasked with smothering fire and radioactive debris following reactor disruption accident
- experienced external whole-body acute exposures to gamma-rays

Slide 9 – Chernobyl first responders (cont.)

- 97 experienced ARS, 28 died
- 22 of 69 who recovered from ARS died in following 19 years from various causes
- none of 140 responders exposed to <2,000 mSv died from radiation-induced causes

Slide 10 – Chernobyl first responders (cont.)

- data supports ARS threshold dose of 2 Sv (equivalent to 2 Gy for gamma-rays)

Slide 11 – Goiania radiological accident (1987)

- radioactive contamination accident occurred in Goiania, Brazil after unsecured radiotherapy source stolen from abandoned hospital site and subsequently handled by many people

Slide 12 – Goiania radiological accident (cont.)

- casualties incurred initial acute whole-body external exposure followed by chronic whole-body internal exposure at low dose-rate from ingested Cs-137
- 8 people experienced ARS, 4 died
- 20 people exposed to high radiation doses >1 Gy did not experience radiation sickness and did not incur cancer in following 25 years
- ≈100 people received high radiation doses >200 mGy

Slides 13-15 – internal radiation dose effects table

- internal doses in red were fatal, those in pale yellow marginal, those in green harmless
- internal doses are whole-body absorbed doses from ingestion of indicated radionuclides (note that dose per month is meaningless unit for acute exposures resulting in ARS)

- Litvinenko (Russian KGB defector) died from acute exposure to alpha radiation 22 days after being poisoned with Po-210
- radium dial painter deaths from chronic exposure to alpha radiation from years of Ra-226 accumulation in bones
- Goiania doses <ARS threshold from chronic exposure to beta and gamma-ray radiation
- Fukushima and "Normal body" doses are from chronic exposure to low-dose beta and gamma-ray radiation

Slide 16 – high-dose effects threshold

- High-dose acute exposure threshold for harm of 200 mGy consistent with high-dose effects study data

Slide 18 – Dose Range 1 (0-100 mSv)

- no observable detrimental health effects for either acute or chronic doses
- acute doses include medical diagnostic procedures
- chronic dose from natural background radiation only chronic exposure for public
- no chronic exposures to anyone outside Range 1

Slide 19 – HPS position statement for Range 1 doses – no adverse health effects for low-dose exposures

Slide 20 – illustrates a variety of acute and chronic doses

- acute doses – transatlantic flight, chest x-ray, whole-body CT
- annual chronic doses not meaningful since low dose/dose-rate biological effects not cumulative
- NRC radiation worker administrative limit applies to accumulation of individual acute exposures plus background dose in any 12-month period.

Slide 21 – Dose Ranges 2 (100-500 mSv) and 3 (500-1000 mSv) – only apply to acute doses

Slide 22 – Dose Range 4 (1-3 Sv)

- radiation sickness within 48 hours
- delayed effects (cancer, cataracts, genetic defects, lifespan shortening)

Slide 23 – Dose Ranges 5 (3-5 Sv) and 6 (5-12 Sv)

- Range 5: ARS – radiation sickness within hours
- Range 6: ARS – death within days; fractionation of doses in this range for therapeutic radiology